Sustainable Energy NOW
www.sen.asn.au

SAM Virtual Conference 2015

SEN Interactive Renewable Energy Network tool
- SIREN -

Angus King, Sustainable Energy Now

Promoting practical, affordable strategies for the adoption of renewable energy toward a sustainable future

About Sustainable Energy Now

SEN is a not-for-profit association incorporated in Western Australia (WA) with a focus on renewable energy

Our Definition of Sustainable Energy

"Energy that is renewable within a human lifetime and can be produced safely and equitably for all time with minimal impact on the environment and future inhabitants". We believe this does not include nuclear power with its many unresolved issues

Our Focus

Raise awareness of how a mix of renewable energy technologies are able to meet Western Australia's energy needs, with a particular focus on the main electricity grid, called the South West Interconnected System (SWIS)

Our Computer Simulation

Demonstrate how electricity demand on the SWIS may be met by a mix of renewable energy sources. Users are able to explore potential location and scale of renewable energy sources (stations, storage, transmission) to meet electricity demand

Simulation Requirements

Demonstrate to policy makers, politicians and the public that optimized renewable energy scenarios are economic NOW

1. Robust models for potential generation from renewable plants in the area of interest and the costs involved

2. A map covering the area for the electricity network interest enabling easy placement of new renewable energy stations

3. Weather data covering the area and time-frame of interest

4. Details on the existing electricity generation capacity and the transmission network

5. A relatively simple interface to enable novice as well as expert usage

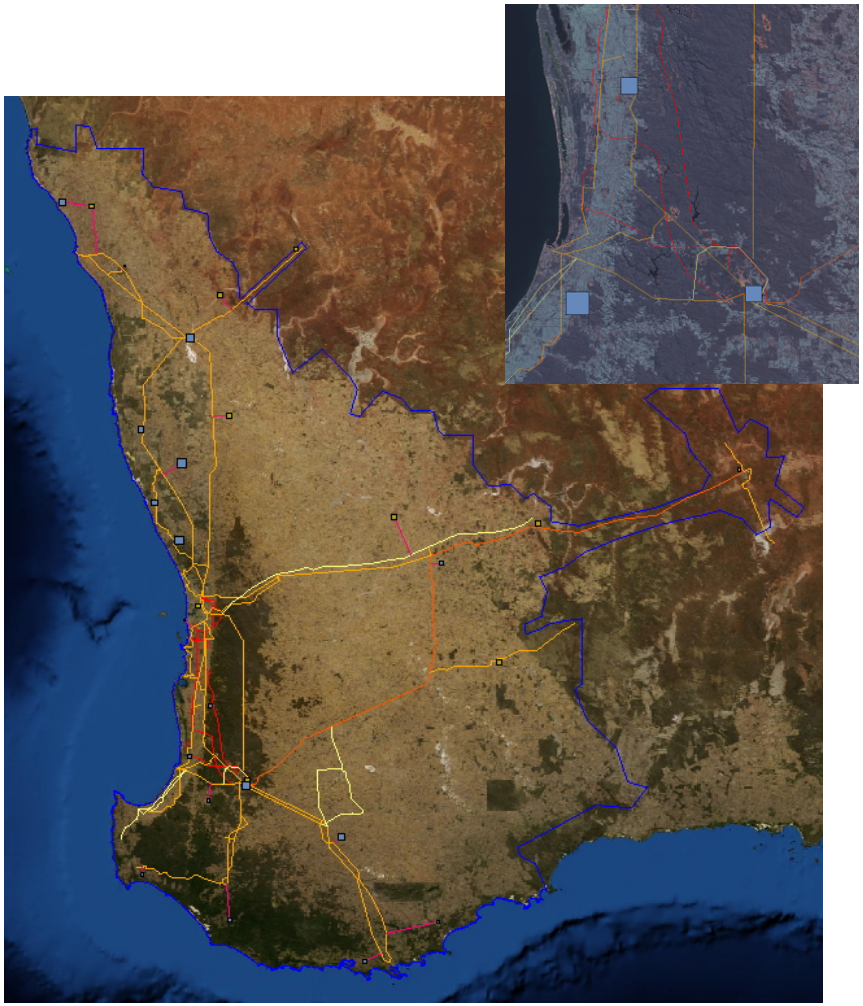
6. Potential for wider application and free / open availability

1. Robust Models – SAM's SDK

- SAM's validated technology modules are key to the simulation
- Using API calls to the SAM Simulation Core (SSC) software library to model generation
- Invoke the appropriate SAM module for each station to produce a composite result for generation and financing costs
- Technology Models
  - Photovoltaic - pvwattsv5
  - Solar Thermal - tcsmoltensalt for "power tower"
  - Wind - windpower
- Financial Models
  - annualoutput
  - Utility IPP - ippppa

2. A Map

- Any suitable graphic image
  - most geographic projections should work
- Default map derived from MapQuest Open Aerial Tiles
  - Download map tiles for the area of interest and the level of zoom required and "stitch" them into a single graphic image.
  - Map projection for these tiles is EPSG:3857 - WGS 84 / Popular Visualisation Pseudo-Mercator. It's a Spherical Mercator projection coordinate system popularized by web services such as Google and later OpenStreetMap. Presents an area of the earth as a square image

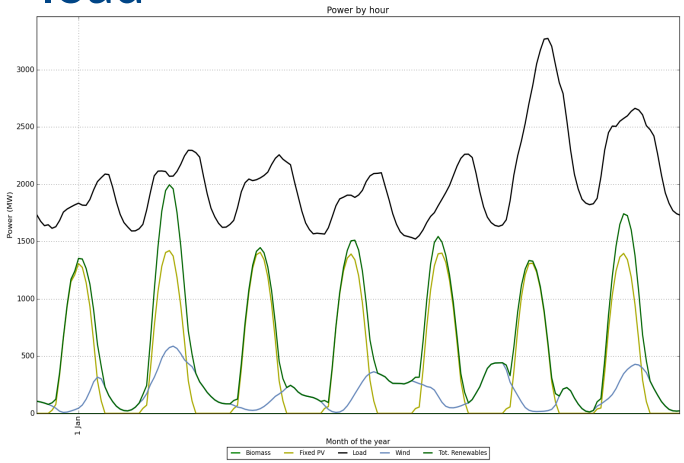


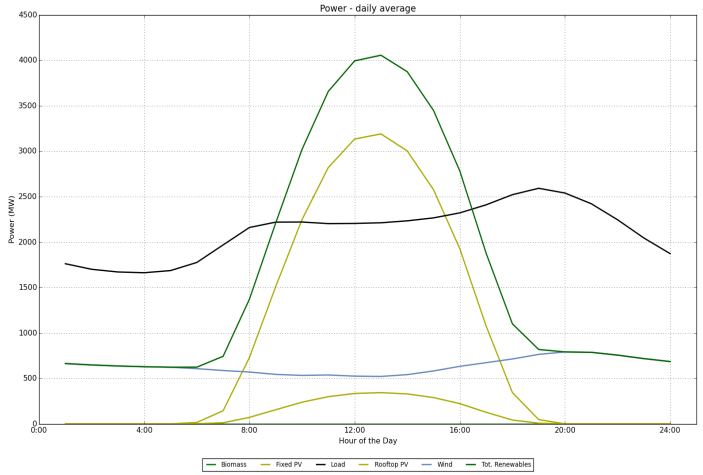
3. Weather Data

- Weather data that reflects actual weather conditions of the past enables any model to better map actual load demand
  - For example, hot weather increases air conditioning load
- NASA MERRA data (Modern-era Retrospective Analysis for Research and Applications)
  - NASA reanalysed satellite data
  - Worldwide solar and wind data (1/2° latitude x 2/3° longitude; approx 55Km x 55Km for the SWIS; 34 x 34 miles)
- Manipulate data into file formats suitable for SAM
  - Wind data needs no manipulation. Data at 50m heights suitable for analysis of wind turbines (We create .srw format files)
  - Solar data relies on a single radiation field. By utilising NRELs Direct Insolation Solar Code (DISC) and DNI-GHI to DHI Calculator it is possible to generate the variables required for the solar weather files (We create .smw format files)

4. Existing electricity network

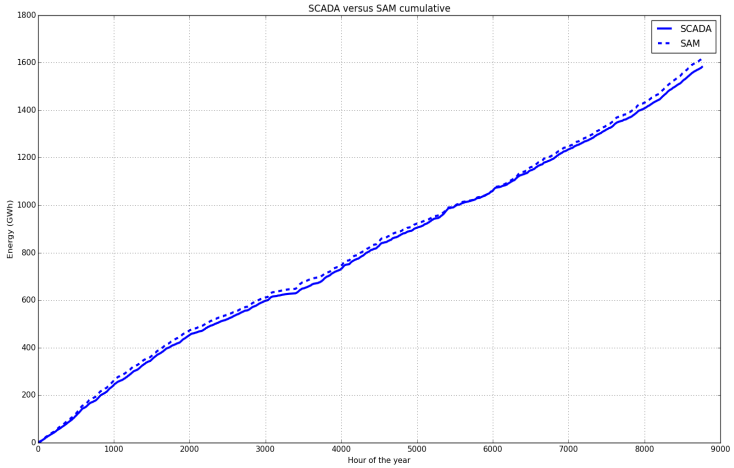
- Initial focus is the South West Interconnected System
- WA Independent Market Operator has publicly available hourly data:
  - Existing generators (augmented with location and turbine type)
  - Load data for the network
  - Detailed generation (SCADA) data for each generator
- Can compare calculated hourly renewable generation to actual load

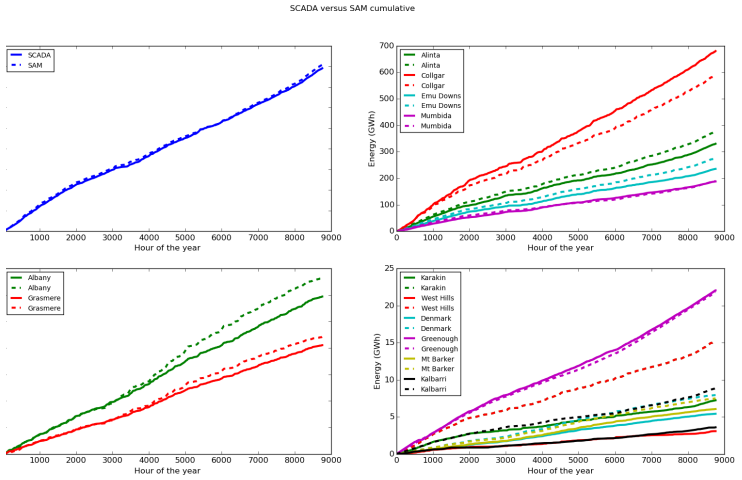




4a. How does it compare?

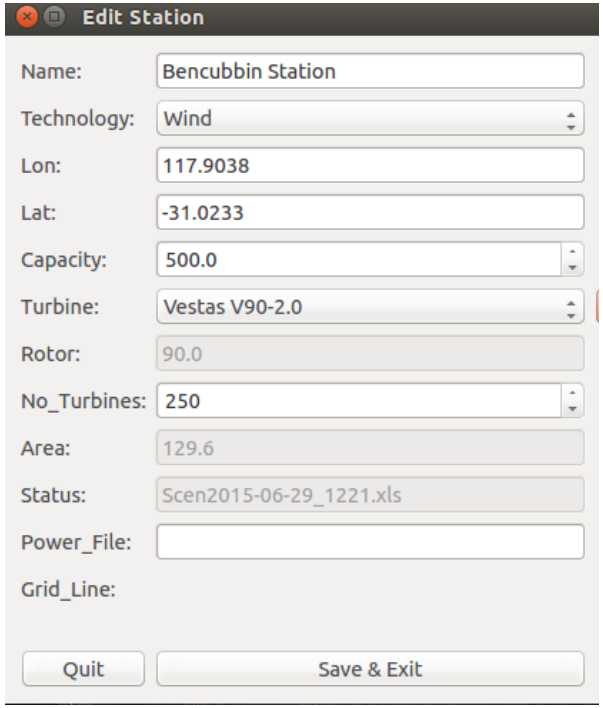
- Validated SAM calculated generation with actual generation
  - Average correlation is 0.77, varying from 0.70 to 0.83 for wind and 0.95 for the one utility scale PV farm on the network
  - Validates use of SAM modulss and NASA MERRA data
  - Correlation of actual generation data with calculated generation using these created files has given enough confidence to use this approach



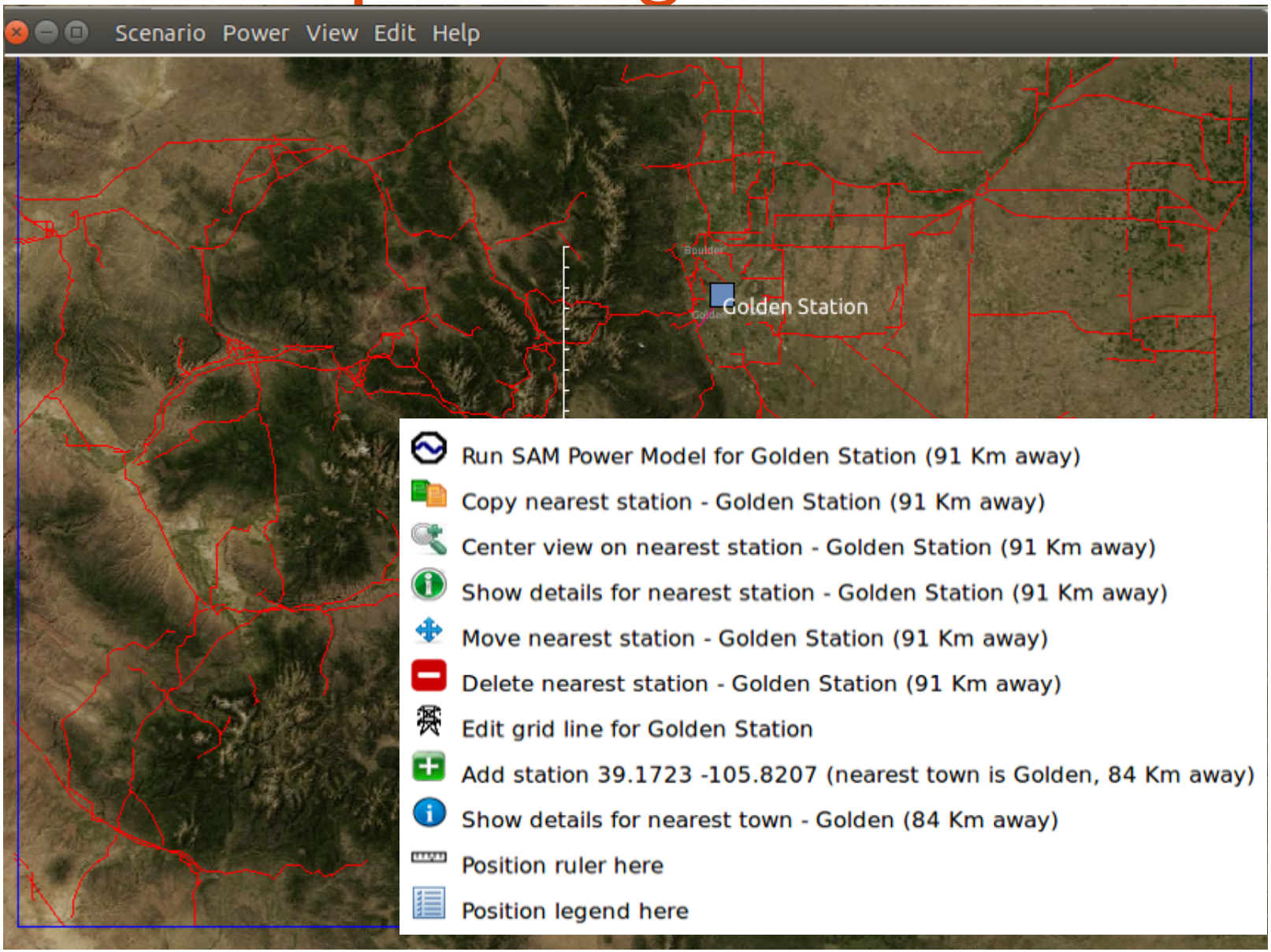


5. Simple Interface

- Map of the network showing existing generation and transmission infrastructure
- Novice mode requires no detailed user input
  - SAM variable values "defined" by the size and location of the station
- Expert mode makes all SAM variables available
- Can easily add new generation
- Save and reload "scenarios"
- Extensive graphical and tabular output to enable an analysis of the scenario versus load, including transmission costs, LCOE, …
- Can simulate load growth into the future



5a. Example Usage



6. Wider and Open Application

- Data sources are publicly available
  - Models – SAM
  - Maps – OpenStreet Map (MapQuest)
  - Weather – NASA MERRA
  - Network – Location/area dependent
- Developed to support any geographic area
- Developed with open source products
  - Python with it's extensive range of libraries
  - Packaged binaries
- Licensed under the GNU
  - GNU Affero General Public License

Further development

- Focus is likely to remain at utility scale
- Finish initial development :-)
- Other SAM technology models
- Fill load gaps
  - Storage
  - Electric vehicles
  - DSM
  - Efficiency
- Transmission / Smart Grid
- Optimisation of scenarios
- Any thoughts, feedback is welcome (see next slide for contact details)

More Information

- SEN
  - http://www.sen.asn.au/
  - Tech Team Leader – Steve Gates smgates@tpg.com.au
  - Developer – Angus King angus@ozsolarwind.com
- SAM SDK
  - https://sam.nrel.gov/sdk
- MapQuest Tiles
  - http://developer.mapquest.com/web/products/open/map
- MERRA Data
  - http://gmao.gsfc.nasa.gov/merra/
- Independent Market Operator
  - http://www.imowa.com.au/
  - Market Data http://data.imowa.com.au/